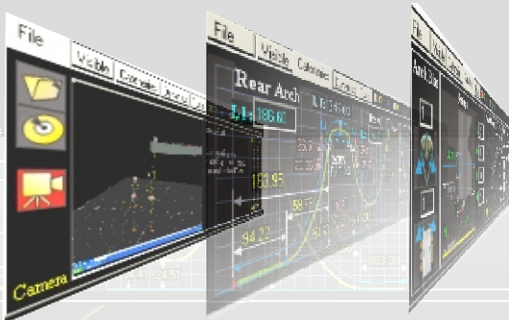


# TUI Virtual Field



The TUI virtual field gives the user unprecedented insight and control over all aspects related to project planning, design, and visualization..

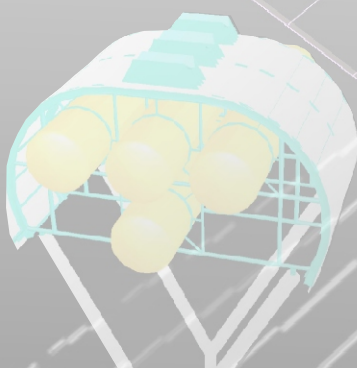
- High level user interaction
- Provides a unique tool set for designers and planners.
- Real time plotting and adjustment of riser and mooring line catenaries
- Touchdown and endpoints are mapped, with critical data displayed in tabbed page format.
- Mid Water Arch positions update as a function of tension balance, which is effected by multiple vectors including vessel location, line lengths, MWA height and buoyancy (all of which can be adjusted by the user)



Scenes can be stored and loaded, and a full resolution screen print is saved with each file. A 'dynamics' page provides heave simulation, and vessel movements can be recorded and played back.

- 2D maps and 3D models are combined seamlessly as scene content
- Object visibility can be toggled to reveal a complex scene, or one of specific focus

Perform a virtual SIT complete with object and tether collision detections.



Expand to incorporate external sensors such as GPS, Pitch/Roll, gyro, depth ... for real time updates on site or remote.

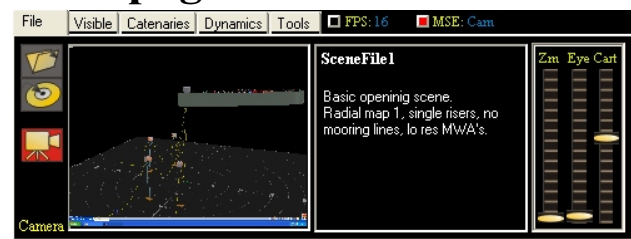


# TUI Virtual Field (TUI VF) ver 1 : Package Overview

The TUI Virtual Field software has been developed in response to requests from the TUI project managers (and the wider industry) for a comprehensive application that encapsulates catenary and dynamic simulations, virtual camera control and navigation, file save and open routines, and field customization utilities. This is the first release of that package, which combines computer processing grunt with unique functionality and an elegant and intuitive user interface. Great care has been taken to adhere to standard catenary equations and their derivatives, so all profiles generated in the simulations are valid.

The application currently comprises 5 tabbed pages, each providing specific functionality. The following paragraphs provide a brief overview of each page's functionality, followed by more detailed descriptions in subsequent pages:

## 'File' page

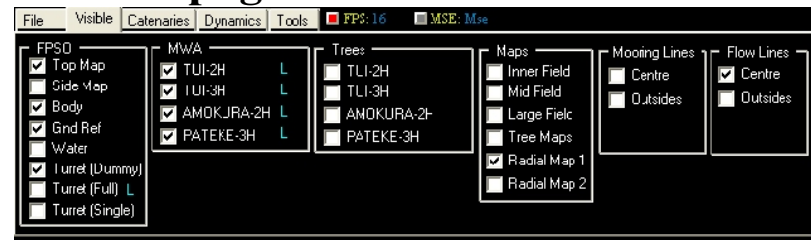


File open and save buttons allow the user to store many virtual field configurations with bitmaps.

A notes sub page allows the user to record notes specific to the saved scene.

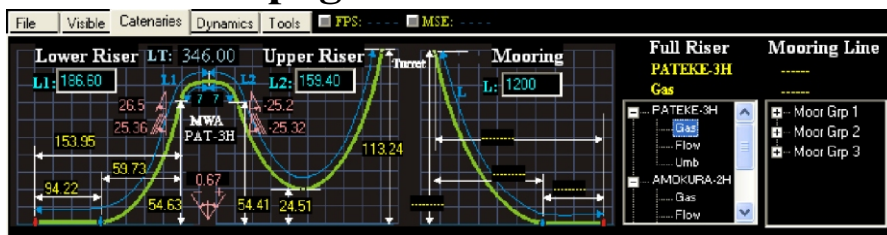
Complete control of the virtual camera is also accessed from this page.

## 'Visible' page



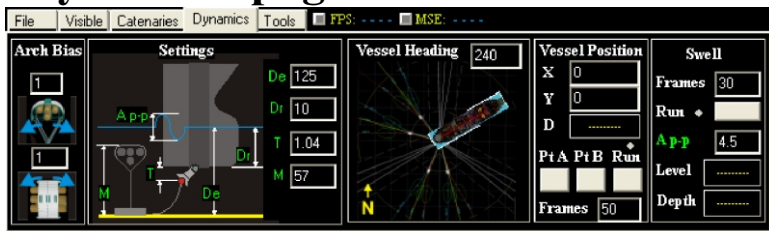
Control the visibility and resolution of all models in the scene to reveal a field of high complexity or one of specific focus.

## 'Catenaries' page



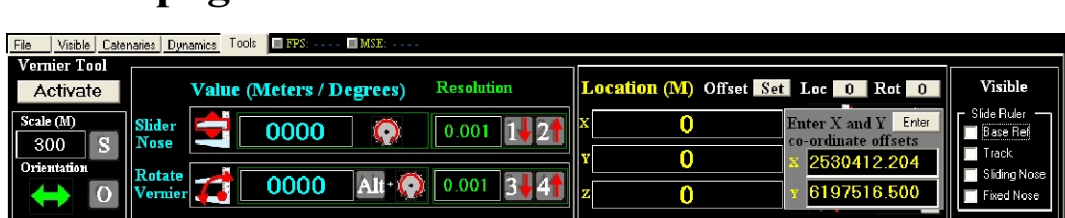
Use this page to dynamically adjust the lengths of riser and mooring line catenaries. The large amounts of data generated from the variables is displayed graphical format, including the MWA 'lean' angles that result from any catenary tension imbalances.

## 'Dynamics' page



Set buoyancy values for the MWA. Set water depth, Vessel draught, turret draught, and MWA height. Adjust vessel heading and position. Store A/B points and enact dynamic movements between the points. Simulate swell. All adjustments interact with all other field elements for full simulations and dynamics.

## 'Tools' page



The 'Tools' page allows basic measurements of distances and angles in the field using a virtual slide ruler (with adjustable calipers) .

# Getting Started

## Input Device


Many input device options were considered and tried, including multi-axis joystick, and flight sim joystick, however, the mouse and keyboard were used due to their pervasiveness and familiarity. The mouse must have a scroll wheel, which has been used extensively for data input. The keyboard has also been used for 'hot keys', ie input triggers beyond alpha numerics.

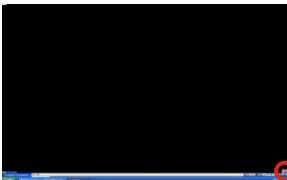
## Launching the application

Most developers of simulation software will use a 3rd party graphics engine, which is controlled by their 'front end' software. This frees up the developer to focus on the specific application (would I design an operating system to write a database application - probably not). Truespace 6.6 has been chosen as the 3D engine behind this application.

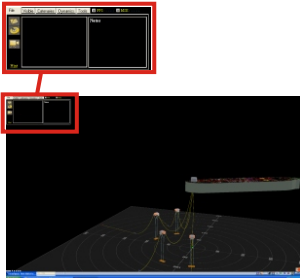
The virtual field scene is loaded automatically when truespace is launched. The scene takes approx 10 secs to load, due to its large file size. A black screen appears after the scene has loaded. Click on the small icon that appears on the bottom right of the screen. This will launch the 'TUI Virtual Field Interface' (TUI-VFI), which will appear at the top Left of the screen. When the 'TUI-VFI' has loaded, a basic scene will appear, which is a perspective of the FPSO with low res MWA's, radial ground map, and central risers.

There are other ways to launch the scene. An obvious one is to click on the scene icon in windows explorer, which tells Truespace to load with this scene.

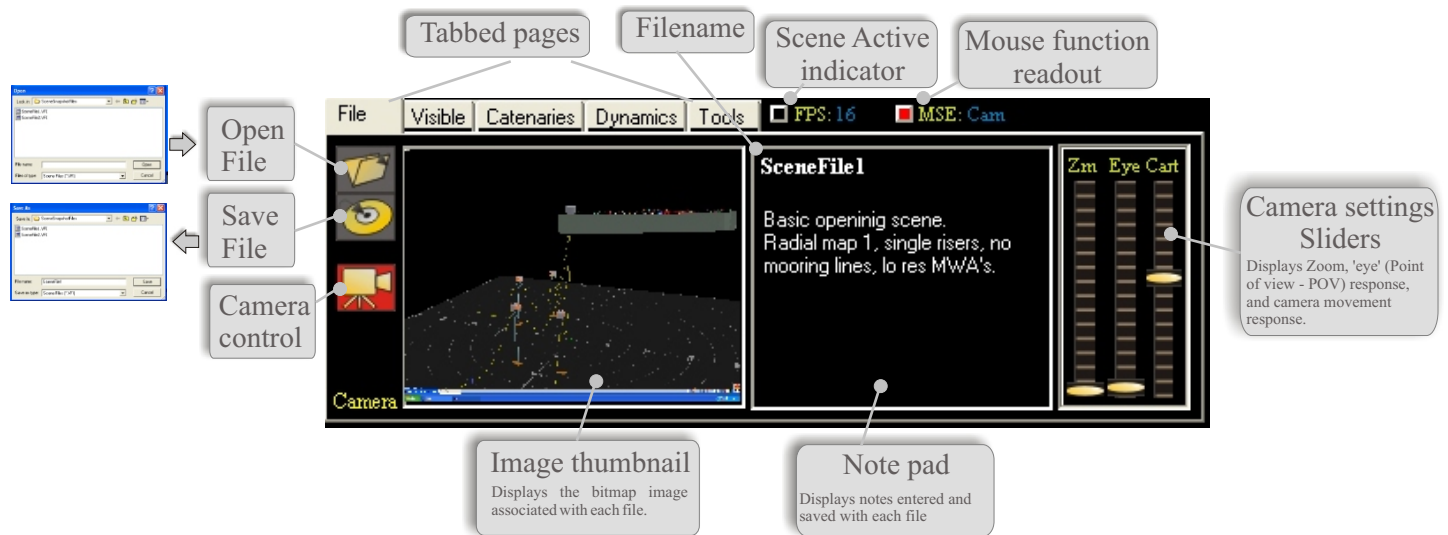
1.  Launch the 3D graphics engine by clicking this icon on the desktop screen.

2.  Click on the icon at the bottom right of the opening screen to launch the TUI field interface.

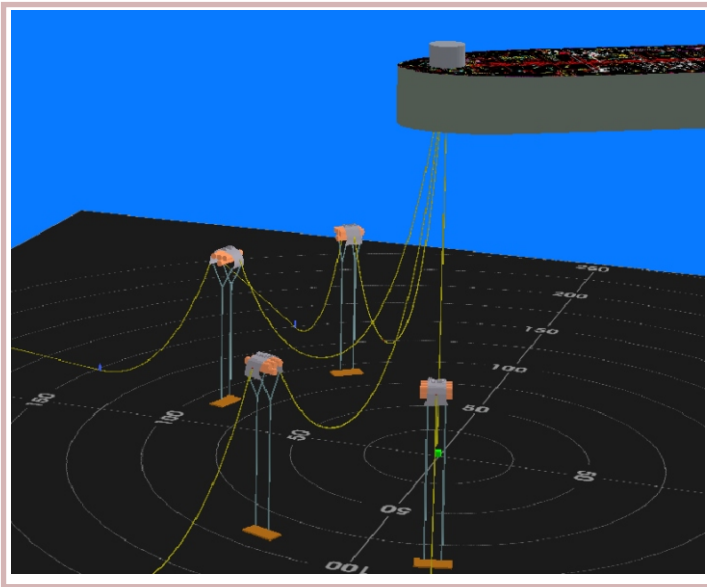
2.  Further clicks on this icon will toggle the visibility of the TUI-VFI.

3.  The default scene appears (FPSO, Low res MWA, central risers) as well as the TUI-VFI.

If at any stage you wish to 'hide' the VFI, click again on the orange icon at the bottom RHS of screen . The VFI application will disappear. Click again on the orange icon on the bottom right of the screen, and the application will re-appear. This may be useful if you wish to capture the screen, (although there is a better way to do this from the 'file' page) or show the full image without the interface.



## Opening scene.



When the VFI application loads, a basic scene is displayed, similar to the one shown. The camera angle is very wide (low zoom), with a perspective view of the TUI field centre. The FPSO top map and body are shown, but only the 'dummy turret' is visible. Center riser lines are visible. The mooring lines are not shown. The turret has a center marker (bright green) placed directly beneath it, on the ground. This helps to identify the turret X & Y position when the vessel moves. The MWA structures are low resolution, ie, only a small number of polygons have been used for their models. All the high resolution models are also in the scene, and its entirely up to the user to determine scene complexity. Scenes can be customized by altering many properties such as model visibility, catenary lengths, vessel position, draughts, heights, and buoyancy. Adjust the camera position using the mouse/hotkey combinations, and become familiar with the camera control concepts.



## Open file.

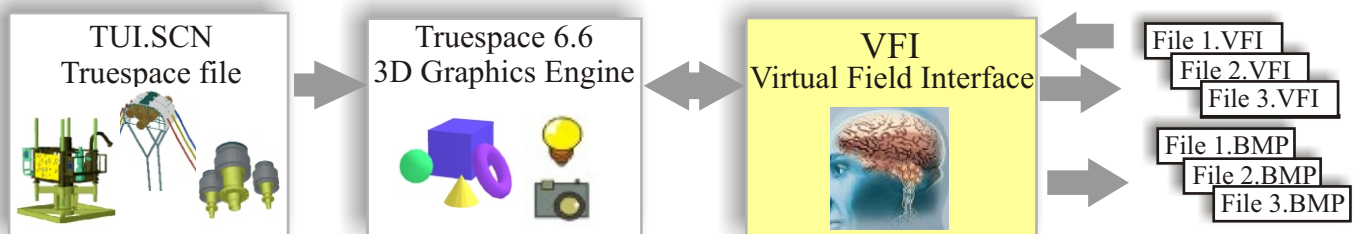
- Event** Left mouse pointer click on the button
- Result** familiar windows 'open file' dialog box appears.
- Action** Select a .VFI file (Virtual field Interface) to 'open', or cancel.

The VFI thumbnail viewer displays the bitmap (.bmp) that is stored with each .VFI file. The bitmap is *full screen resolution*, and having it as a separate file allows you to use it in any graphics application or presentation. The file name is displayed above the note pad. Saved notes are displayed in the notepad.

The distinction should now be drawn between the VFI file and the single Truespace 6.6 base file specific to this application. The base file is a native Truespace 6.6 read only format (.scn), which contains all the 3D models, maps, lights, and camera. This file is never changed, or saved to, and the user will probably never encounter this file under normal use.

A .VFI file, on the other hand, is created for each TUI field. The VFI file contains all the functions, procedures, and saved properties for scene customization and simulations.

The VFI application requires that both files (.VFI & .bmp) be in the same directory when opening.



## ... File



### Save file.

**Event** Left mouse pointer click on the button

**Result** familiar windows 'Save file' dialog box appears

**Action** Enter a file name and save a .VFI file with it's associated bitmap (.bmp) of your configured scene, or cancel.

The .VFI files are small - approx 10kb. The .bmp files are approx 9 Mb for a screen res 1920 x 1200. The user will probably have many saved files in multiple directories, the largest files being the screen images. The image on the right shows the 'pairing' of VFI files and BMP files in the same directory. Everything in the scene is saved including camera location and zoom (The scene file record is shown in the table below)

SceneFile1	9,001 KB	Bitmap Image
SceneFile1.VFI	9 KB	VFI File
SceneFile2	9,001 KB	Bitmap Image
SceneFile2.VFI	9 KB	VFI File

### VFI file

The table below is the record of parameters saved with each file. Extra parameters may be added as the application is expanded.

#### Doc's

File Name  
Notes

#### Catenary lengths

Upper Riser Catenary Lengths  
Lower Riser Catenary Lengths  
Mooring Line Lengths

#### Visibility

Model Visible Resolution Records

#### Camera

Camera Location  
Camera Rotation  
Camera Zoom  
Camera Movement Response  
Camera POV (Point of view) response

#### MWA

MWA Tilt Bias  
MWA Rotation Bias  
MWAHeight

#### Vessel

Vessel Heading  
Vessel Draught  
Turret Draught  
Water Depth  
Vessel Location  
Vessel Position A  
Vessel Position B  
Vessel AB Frames

#### Swell

Swell Frames  
Swell Amplitude (p-p)



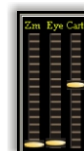
### Camera Control.

**Event** Left mouse pointer click on the button

**Result** Camera becomes active / mouse pointer inactive.  
The camera settings slider panel opens.  
Scene active\*

**Action** Use the Hot key's - mouse combinations for camera placement and operation.

Scene active



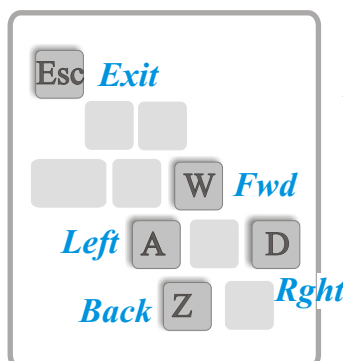
Camera settings slider panel opens

\*Scene active: Processing loop begins which results in a scene update rate of approx 20 frames / sec. The frame rate will drop as the calculations (simulation complexity) increase. The 'FPS' (frames per second) indicator begins flashing to indicate 'scene active'. The user can use this flash rate (as well as the FPS readout) to gauge the processor load presented by the scene.

All aspects of camera movement and placement are controlled by the mouse and 'hot keys'. 'Ctrl' + L or R mouse buttons control camera zoom. The mouse X & Y position determine the camera POV (point of view), much like a pan and tilt camera. 'Ctrl' + mouse wheel alters the POV response, ie POV response should be set low with high zoom, otherwise a small mouse X/Y movement will result in a rapid sweep of the scene. Moving the camera in the scene is achieved with the W,A,D,Z key group on the left of the keyboard. Rotating the mouse wheel will adjust the camera's move response. Consult the chart on the right for more information. 'Esc' exits the camera control routine, and re-enables the mouse pointer.

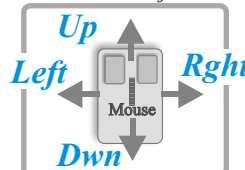
### Camera control chart

#### Camera Move



#### POV Move

POV: Point of view



#### Zoom



#### POV Move Rate

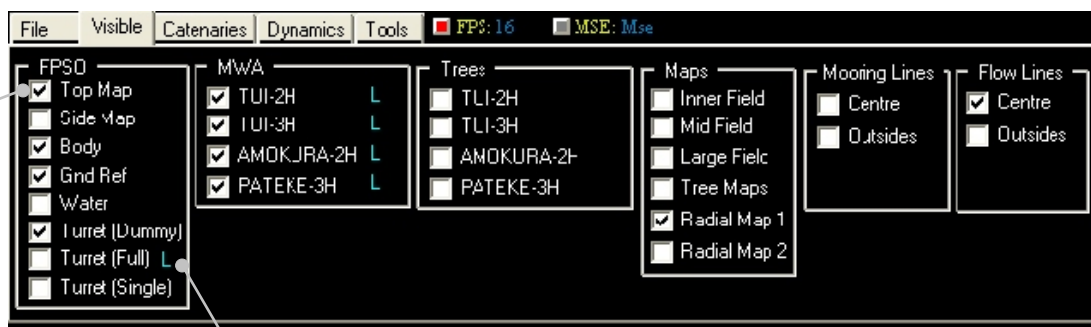


#### Cam Move Rate



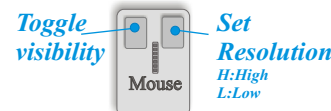
## Visible

Visibility  
Checkbox



Resolution  
designator

*Set Vis / Res*



### ☒ TUI-2H **CheckBox**

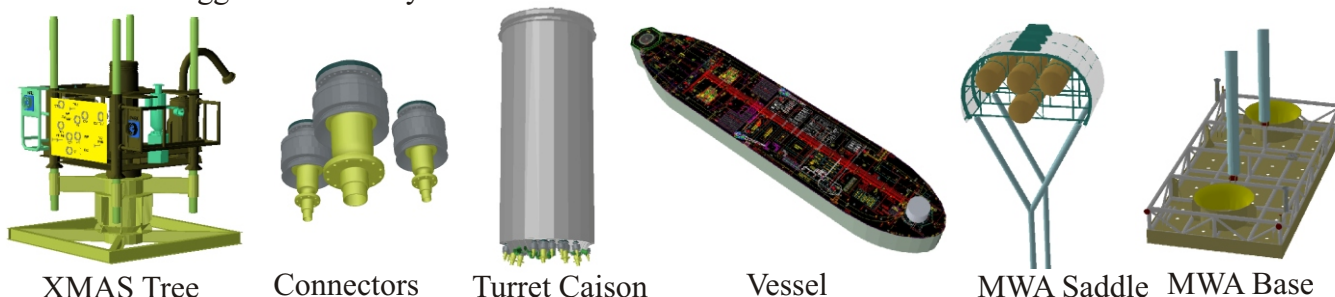
**Event** Left mouse pointer click in the check box

**Result** Clears or sets the checkbox tick, and toggles the visibility of the specific object.

**Action** Set or clear the visibility of any scene elements specified in this page.

This is a very straightforward page. The checkbox reflects the object's current state, ie if the checkbox is ticked the object is visible. Clicking inside a checkbox will toggle (change) the visibility of the object specified in it's accompanying text. As more objects are shown, more burden is placed on the computer's processor, so the user may see a reduction in 'frames per sec' as more complex objects are shown. This may result in stuttered updates when moving the camera, or running simulation routines such as vessel moves. For these reasons, the user should use discretion when showing objects. The user should also exercise caution when showing large maps (ie 'Mid Field', & 'Large Field') when the camera is close to the ground, as this may create some vertex distortions.

The user can toggle the visibility of these and other scene models:



XMAS Tree

Connectors

Turret Caison

Vessel

MWA Saddle

MWA Base

### ☒ Turret (Full) **CheckBox**



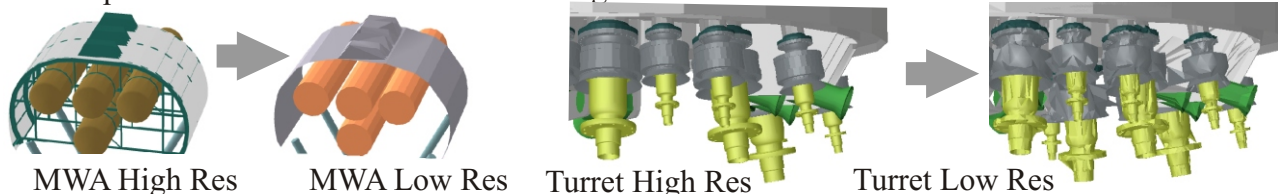
**Event** Right mouse pointer click on the checkbox or label

**Result** Opens the resolution menu.

**Action** Left click on H or L to set the object resolution.

If the user right clicks over a checkbox that has a blue resolution designator, a small 'resolution' menu appears. A left click on either the H or L label will set the object's resolution to high or low. Only objects with a high number of polygons have this option, ie the turret and MWA structures. It will be essential to set the MWA structures to low resolution during all camera and simulation operations, otherwise the frame rate will be too low. Likewise, only the 'dummy' turret should be visible during dynamic operations. When the camera is in position, and dynamics switched off, the objects can be switched to high resolutions for presentation or screen shots.

These pictures show the contrast between High and Low resolutions



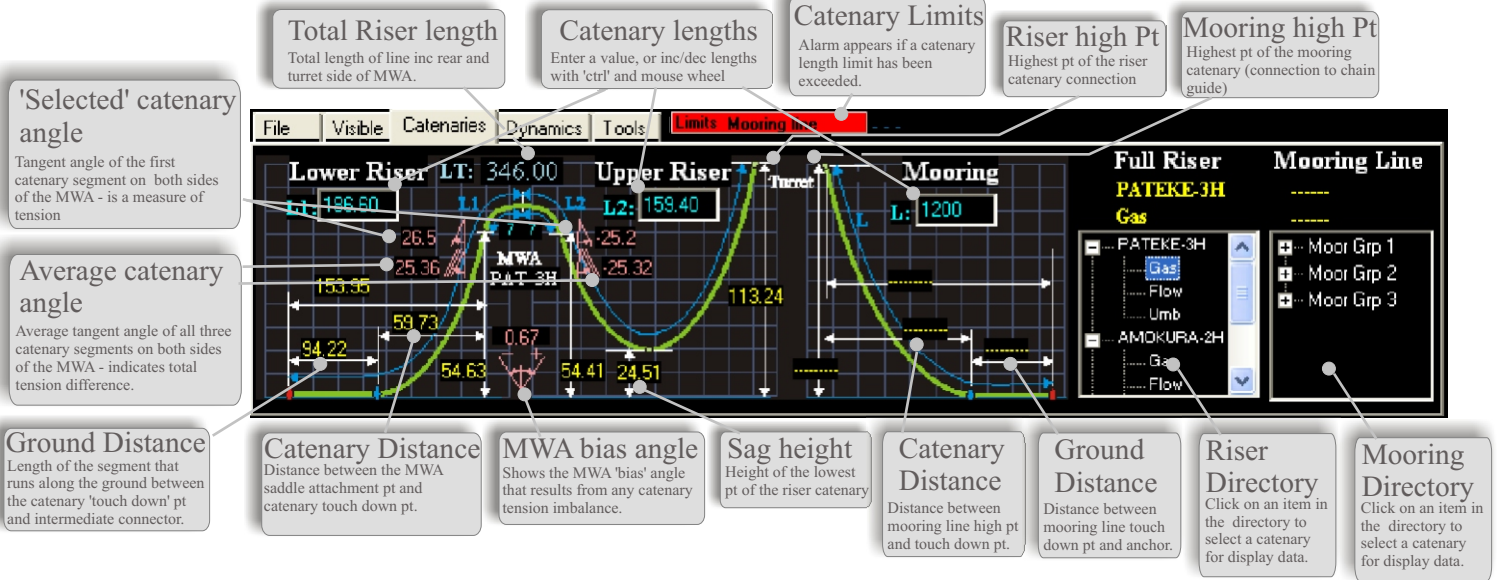
MWA High Res

MWA Low Res

Turret High Res





Turret Low Res

# Catenaries



Lower Riser	Upper Riser	Mooring
L1: 186.60	L2: 159.40	L: 1200.00

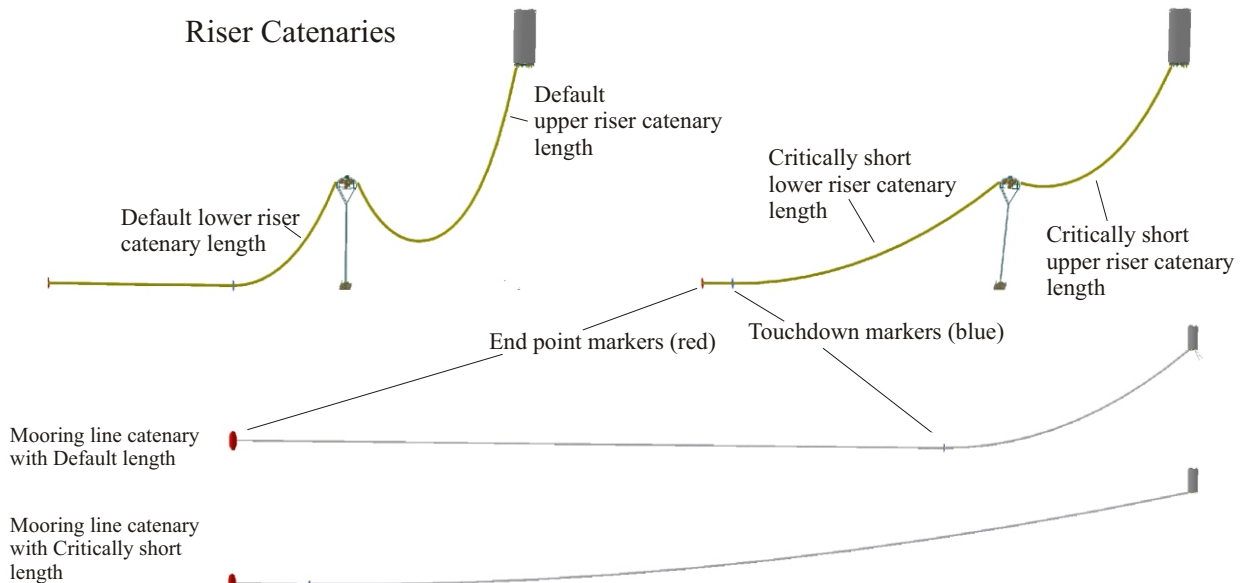
## Length adjust edit

- Event** Left mouse pointer click in the edit box
- Result** Edit box turns red, scene active.
- Action** Type in a new line length and hit the 'Enter' key or Press the 'ctrl' key and rotate the mouse wheel to adjust the selected line length (by 1).
- 


 OR
 

The edit box will turn red when the user left mouse clicks inside the box. Hold down the 'Ctrl' key and rotate the to change the numeric value and the catenary length dynamically. Alternatively, enter a numeric value into the box and press 'enter' to change the catenary length. *The return key must be hit* if a number has been entered directly into the edit box. If a number is entered, and the user changes focus to another control *without hitting the return key*, the value in the edit box will revert back to the last saved value, and will not be entered into the VFI record.

Limits: Mooring line
Limits: Riser
Limits: Rear Arch Cat

One of these alarms will appear if the catenary length constraint is exceeded. A left mouse click in the red alarm box will erase it. The user should then type a valid length into the appropriate edit box and press the 'enter' key. The images below show the mooring and riser catenaries at default lengths, and critically shortened lengths.



The blue marker designates a catenary 'touchdown' point. The red marker designates the 'end point'. The end point for the full riser is the intermediate connector, and the anchor for the mooring line. Notice the touchdown (blue marker) moving closer to the end point (red marker) as the catenary length decreases.

## ... Catenaries



**Riser directory.**

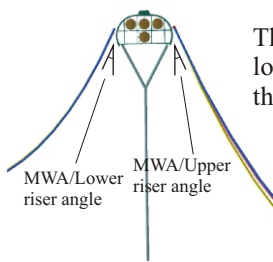
**Mooring line directory.**

**Event** Left mouse pointer click on a directory sub-item

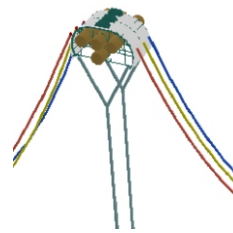
**Result** Selects a riser or mooring line for display data and adjustment.  
The selected catenary is identified by it's increased radius.

The riser tree view presents 4 groups of 3 risers (one group for each XMAS tree). Click on a specific riser to select it as the data focus. All the numeric data displayed in the catenary page will pertain to this selection. Any changes in line length will be particular to this selection. The mooring line tree view has 3 groups of 3 mooring lines. Click on a specific mooring line to select it as the mooring data focus.

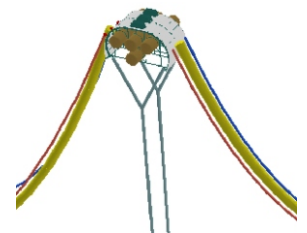
When a riser or mooring line is selected in the directory, the radius of the selected line will increase for identification. Click again on the same selection in the directory, and the radius will toggle back to its default size.



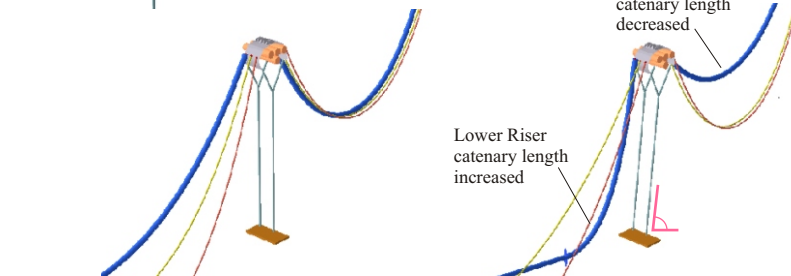
The MWA is 'balanced' when the lower riser angle is the reciprocal of the upper riser angle.



No lines selected



Flow line selected



Selected lower riser  
MWA angle

Average lower riser  
MWA angle

MWA Lean angle  
+ lean toward turret  
- lean away from turret

Selected Upper riser  
MWA angle

Average Upper riser  
MWA angle

	Before Change		After Change	
	Lower	Upper	Lower	Upper
Lengths	159.4m	186.6m	205.6m	131.4m
Single Angle	26.5	-25.2	9.6	-37.6
Ave Angle	25.4	-25.3	27.3	-27.2
MWAAngle	0.67		8.1	

The diagram on the left illustrates the dynamic response of the MWA to changing line lengths. The default line lengths result in a MWA lean angle of 0.67 degrees, which is essentially perpendicular to the ground, or floating straight up. The tension imbalance caused by shortening the upper riser, and lengthening the lower riser, causes the MWA to tilt towards the turret by an angle of 8.1 degrees. The MWA will move to nullify the tension imbalance, so the average angle on either side of the arch will be equal.

# Dynamics

## MWA Bouyancy Index

Enter a value between 0 - 1.  
0: MWA will not respond to any tension differential.  
1: MWA will move to exactly balance any tension differential.

## MWA rotation index

The MWA saddle section will always rotate to face the turret area.  
0: MWA will not rotate.  
1: MWA will rotate to exactly 'look at' the turret area.

## Swell Amplitude

User set swell (heave) peak to peak level

## Water Depth

Enter numeric data for the user set values

## Vessel Heading

Enter a numeric value for the vessel heading.

## A/B Vessel position

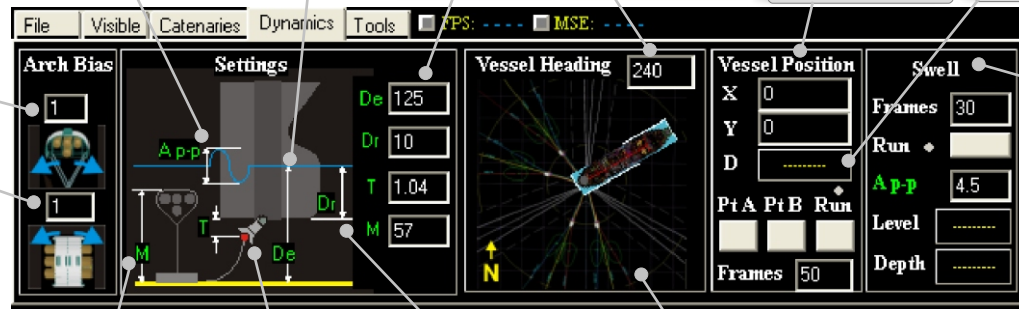
Set two positions between which the vessel will move with full field dynamics

## Vessel distance

Distance the vessel has moved away from the X:0,Y:0 location. It is the length of the 'hypotenuse' of the XY triangle.

## Swell

Simulate the effects of swell (heave) on the vessel and associated field elements.



## MWA height

User set the MWA heights

## Turret Draught

Set the Turret distance below the vessel 'base' or 'bottom' line. The datum is the mooring line connection to the chain guide

## Vessel Draught

Set the vessel bottom distance below the water line.

## Vessel Heading Map

Vessel image rotates to reflect the vessel heading.



## Arch Tilt Bias edit

## Arch Rotation Bias edit

### Event

Left mouse pointer click in the edit box

### Result

Edit box turns green.

### Action

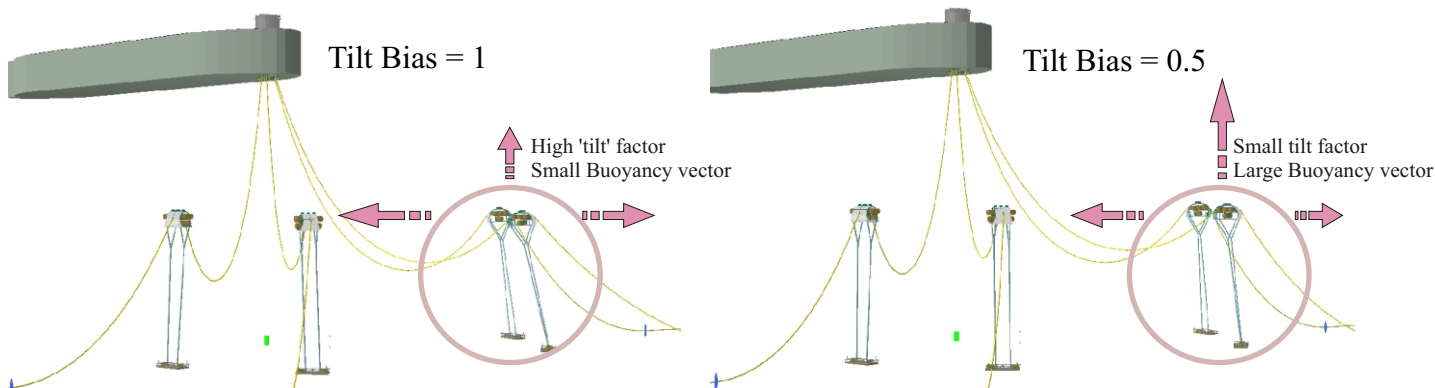
Type in a new bias value for the MWA tilt or rotate, then press enter.

3.1415

Edit box turns green

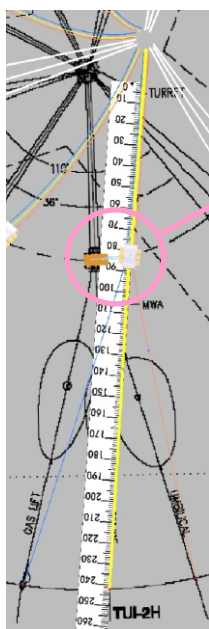
Enter

Hit enter key after data entry



the scenes above show the effects of tilt bias on the MWA 'lean' angles. The tilt bias is be a measure of 'buoyancy', which is the upward vector. The two horizontal vectors are the opposing catenary tensions. If the upward 'buoyancy' vector is large compared to the horizontal vectors, the arch structure will tend to float straight up, with less tilt.

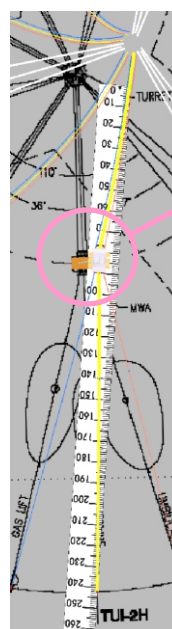
## Rotation Bias = 1



Straight line profile with Rot bias = 1

The image on the left shows the MWA profile as seen from the top, with the vessel off location. With a bias value set to 1, the MWA will pitch to establish a straight line between the turret connection and the intermediate connector, when viewed from above. This effect is demonstrated clearly with the center riser. The virtual ruler has been used in the scene as a straight edge reference along side the center riser line.

## Rotation Bias = 0.5



If the rotation bias value is reduced, the MWA pitch angle will be reduced, and the MWA saddle section and catenary profile will not conform to the straight line between turret and Intermediate connectors. The virtual ruler is used in the scene to illustrate the deviation from the straight tangent between turret and intermediate connections.

## ... Dynamics

De 125  
Dr 10  
T 1.04  
M 57

**Set water depth.**

**Set Vessel draught.**

**Set Turret draught.**

**Set MWA height.**

**Event** Left mouse pointer click in the edit box

**Result** Edit box turns green.

**Action** Type in new values for the water depth, vessel draught, turret draught, or MWA height, then press enter.

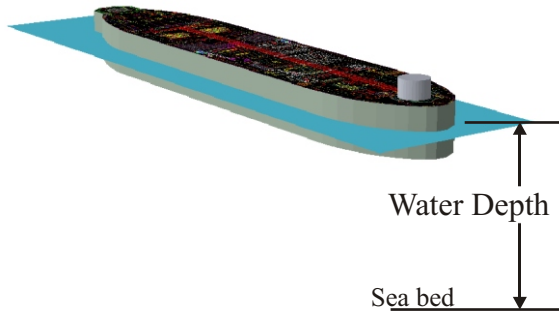
3.1415

Edit box  
turns green

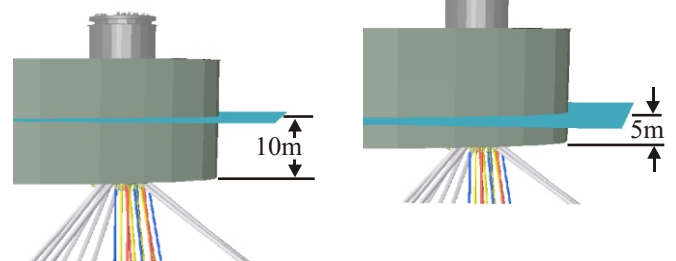
Enter

Hit enter key  
after data  
entry

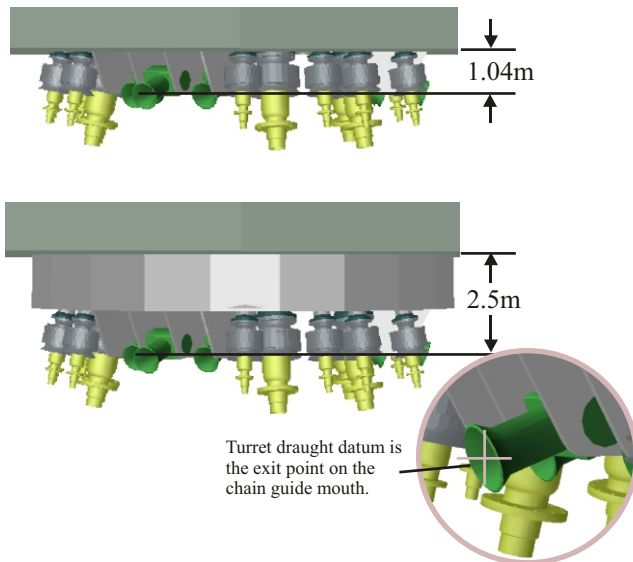
### Water depth



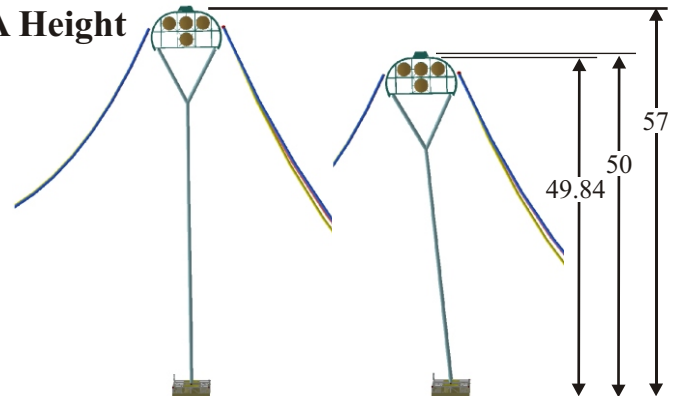
### Vessel draught



### Turret Draught

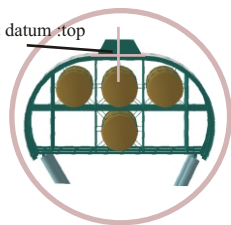


### MWA Height



Adjusting MWA height will effect the 'lean' of the structure, due to the catenary tension imbalance. The actual height of the MWA may not be that specified in the edit box - eg - the MWA on the left is upright for height = 57m. The height of 50m is entered in the edit box. The MWA now exhibits considerable 'lean', and its actual height becomes 49.84m, because of the influence of the catenary tensions. For this reason, any change in MWA height will require catenary length adjustments.

MWA height datum: top  
centre of the saddle



### Vessel heading .

3.1415

Edit box  
turns red



Scene active

Enter

Hit enter key  
after data entry

OR



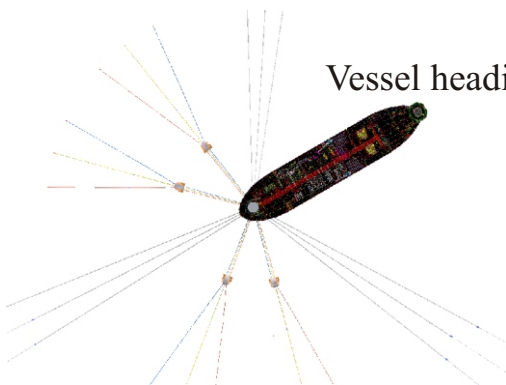
Rotate mouse  
wheel to inc/dec  
vessel heading

**Action:** Left mouse pointer click inside edit box.

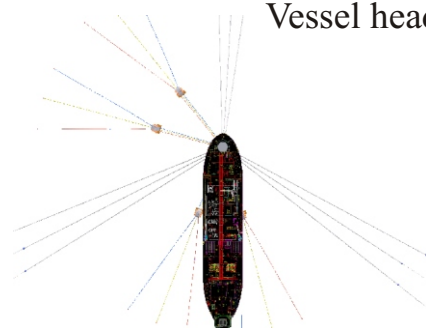
**Result:** Edit box turns red.

Type in a new value for the vessel heading, then press enter - OR - Press 'ctrl' key and rotate mouse wheel to inc/dec vessel heading (by 1).

Vessel heading: 240°



Vessel heading: 0°



## ... Dynamics



### Vessel A/B Position

**Event** Left mouse pointer click in X or Y box's

**Result** Edit box's turns red.

**Action** Type in new values for the vessel x or y position, then press enter - OR - Press 'ctrl' key and rotate mouse wheel to inc/dec vessel x or y position (by 1).



Edit box turns red



Scene active



Hit enter key after data entry

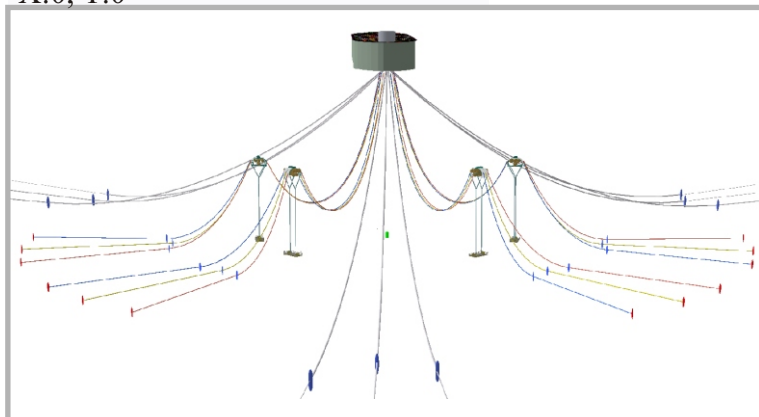
OR



Rotate mouse wheel to inc/dec vessel position

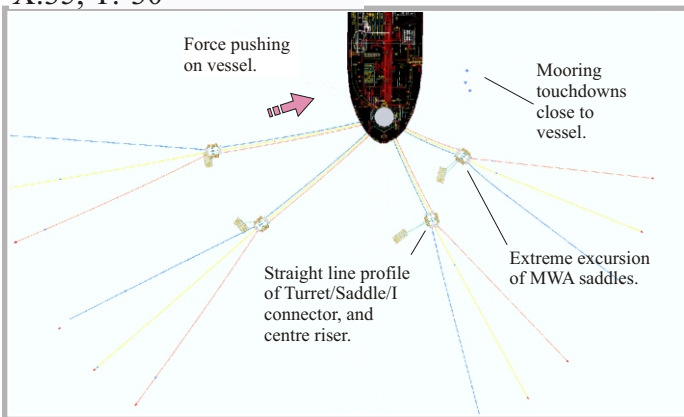
### Default vessel position (Front view)

X:0, Y:0



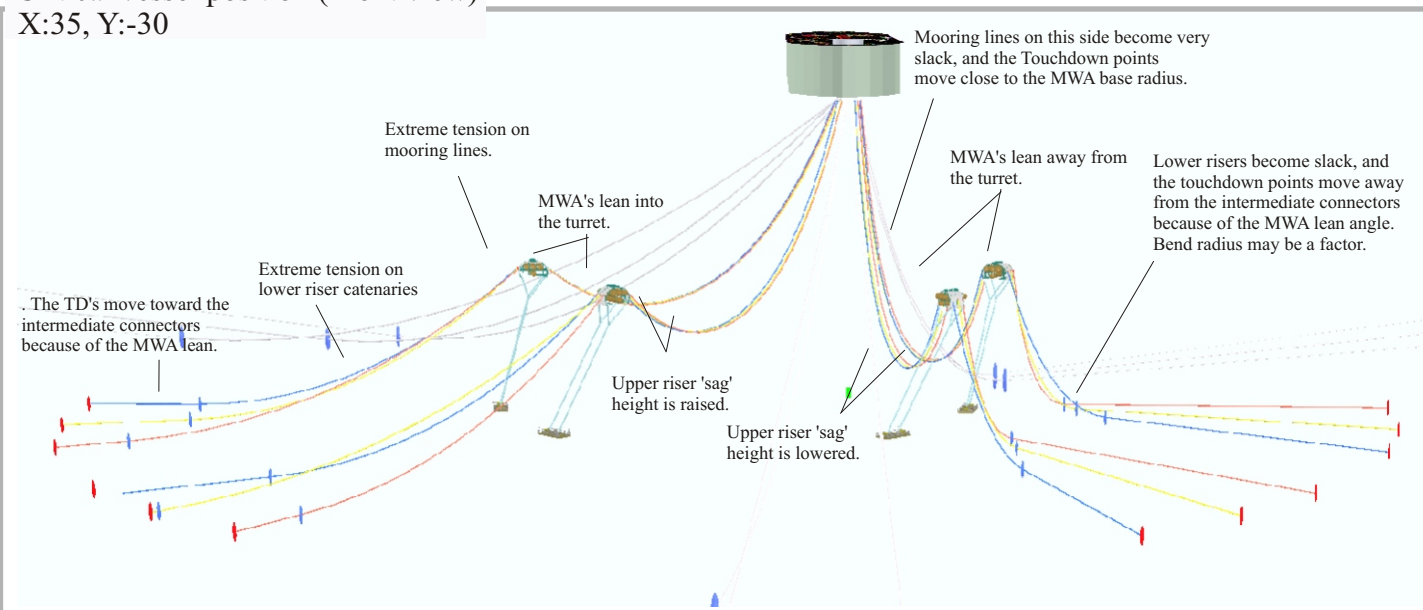
### Critical vessel position (Top View)

X:35, Y:-30



### Critical vessel position (Front view)

X:35, Y:-30



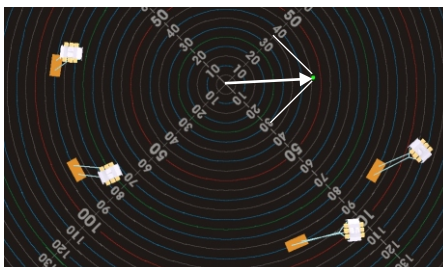
The images above illustrate the effects of the vessel moving off location by -30 meters in the Y plane, and 35 meters in the X plane, which results in a total excursion of 46.1 meters from the origin. The vessel movement is the result of an external force (ie wind), and not the result of mooring line adjustments, so the mooring line lengths are constant. The mooring alarm box appears when the vessel excursion exceeds approx 20-25 meters in any direction, alerting the user that the anchors are about to be dragged in the vessels direction due to the extreme tension on that mooring line group. The vessel movement effects all the dynamic parameters, because everything is tied to the vessel turret. Stated in another way, vessel position effects the mooring and riser line catenary profiles (which effect sag heights and line tensions). The riser catenaries tension imbalance effect the MWA lean angles, which effect the lower riser touchdown points. The extreme MWA lean angle that is seen in the above image results in critical tensions on the lower riser catenary, (TD points close to the intermediate connectors) , which may part the lower riser lines.

Limits Mooring line

Limits Riser

Limits Rear Arch Cat

The example above raised a mooring line alarm, which indicates the anchors will be dragged if the vessel excursion continues. It is also possible that any of the other catenary alarms might be raised under the right conditions.



This image shows the turret marker position on the higher resolution 'radial map 2'. The only other models visible in this image are the low res MWA's. The radial maps give a quick distance indication from the field centre.



The 'distance' readout gives a precise value of vessel excursion from the centre.

## ... Dynamics

**PtA, PtB, Run**

**Frames**

- Event** Left mouse pointer click on Pt A, Pt B buttons.
- Result** Stores the two vessel positions
- Event** Left mouse pointer click on Run button.
- Result** Vessel moves between PtA and PtB with full dynamics.
- Event** Left mouse pointer click in the 'Frames' edit box.
- Result** Edit box turns green.
- Action** Type in the number of frames for the A/B simulation.



**Frames**  
Edit box  
turns green



Hit enter key  
after data  
entry

The user must ensure the scene complexity is not too high as to result in a slow frame rate for the simulation. The frame rate will already be slow due to the large number of calculations required to determine the MWA behaviors and catenary profiles.

**Swell simulation.**

**Frames**

**Run**

**Ap-p**

- Event** Left mouse pointer click in the 'Frames', or 'Ap-p' edit box.
- Result** Edit box turns green.
- Action** Type in the number of frames for swell simulation, or the value of the swell peak-peak amplitude.
- Event** Left mouse pointer click on the 'Run' button.
- Result** Swell simulation begins

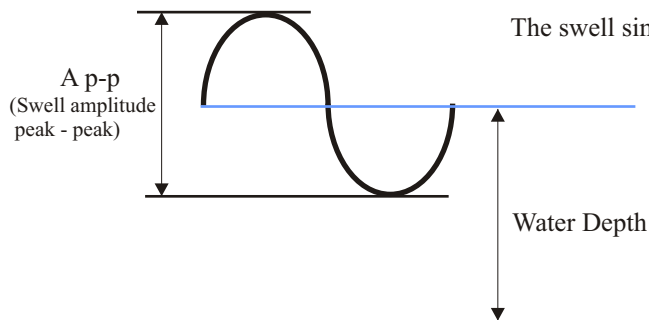


**Frames**



Hit enter key  
after data  
entry

'Level' displays the swell level - water depth.  
'Depth' displays the swell level + water depth.



The swell simulation is based on the trigonometric SIN function.

## Tools

**Activate**  
Click on this button to activate the virtual measurement tool - ie effect Cartesian and angle measurements and movements.

**Slider Nose Adjust**  
Move the 'vernier' nose by rotating the mouse wheel. The offset value from zero is displayed in the readout in meters.

**Resolution**  
Increment or decrement the 'movement' resolution by pressing the '1' key (dec) or '2' key (inc). This res setting applies to the nose movements, and the tool 'Location' movements

**Offset Button**  
Click this button to show the 'Offset Panel', and enter X and Y values to add to the location readouts. The 'Offset' panel values on the right represent the FPSO turret centre.

**Enter X and Y co-ordinate offsets**  
X: 2530412.204  
Y: 6197516.500

**Loc '0'**  
Click this button to reset the tool location to the 0,0,0

**Rot '0'**  
Click this button to reset the tool rotation to 0.

**Scale (Meters)**  
Press the 'S' key to increase the scale of the measuring tool from 0.3M to 3000M.

**Orientation**  
Press the 'O' key to toggle the measurement tool orientation between flat and upright.

**Tool Rotation**  
Adjust the 'vernier' rotation by holding down the 'Alt' key while rotating the mouse wheel. Readout in degrees.

**Resolution**  
Increment or decrement the 'rotation' resolution by pressing the '3' key (dec) or '4' key (inc). This res setting applies only to the tool rotation.

**Location Readouts**  
The X,Y, and Z readouts display the coordinate location of the measurement tool. The "World Co-ordinates" convention is used.

**Tool Movements**  
Move the tool in the X,Y, & Z axis using the hotkey/mouse combinations. If you are looking at the graduated face of the ruler, the movement conventions are: 'Shift' + Mouse Fwd/Back: Move ruler along its long axis. 'Cntrl' + Mouse Left/Right: Move ruler at right angles to its long axis. 'Cntrl' + Mouse L or R button: Move ruler up and down. Movement resolutions are determined by keys '1' (inc) and '2' (dec).

**Visible**  
Show or hide the various components of the measuring tool.

### Activate Measurement Tool Activate

- Event** Left mouse pointer click on the 'Activate' button.
- Result** Measurement tool becomes active.
- Action** Use the Hot Key / Mouse combinations to move and adjust the ruler for field measurements.

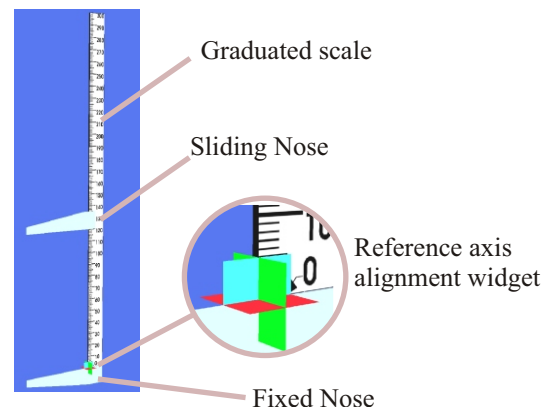
The measurement tool is a virtual ruler with a graduated scale (0 - 300) and a set of adjustable calipers. This allows the user to measure distances and angles with a high degree of accuracy. The ruler can be scaled from 0.3 to 3000 meters. The resolution can be adjusted from 0.001 meters/increment to 100 meters/ increment. The angle resolution can also be scaled from 0.001 degree/increment to 10 degrees / increment.

The ruler is easily moved around the field using the hotkey/mouse combinations.

The visibility of the four components that make up the ruler can be toggled on and off individually.

All the ruler attributes are saved with each scene file.

### Ruler components



### Measurement Tool control chart

<p><b>Move Y</b></p> <p>Shift + Mouse</p>	<p>Moves the tool along its 'long' axis, if you are facing the graduated scale</p>
<p><b>Move X</b></p> <p>Ctrl + Mouse</p>	<p>Moves the tool at right angles to its 'long' axis, if you are facing the graduated scale</p>
<p><b>Move Z</b></p> <p>Down Up</p> <p>Ctrl + Mouse</p>	<p>Moves the tool up and down in the 'Z' (depth) axis.</p>
<p><b>Rotate</b></p> <p>Dec Inc</p> <p>Ctrl + Scroll wheel</p>	<p>Rotates the tool around its reference axis point</p>
<p><b>Exit</b></p> <p>Esc</p>	<p>Press the 'esc' key deactivate the tool, and regain the mouse pointer</p>
<p><b>Movement Resolution</b></p> <p>1 2</p> <p>Dec Inc</p>	<p>Increment or decrement the movement resolution for the adjustable nose and tool location</p>
<p><b>Rotation Resolution</b></p> <p>3 4</p> <p>Dec Inc</p>	<p>Increment or decrement the rotation resolution</p>

# Measurement Examples

## MWA Buoyancy tank height and diameter

The ruler has been positioned in an upright orientation to measure the height of the MWA buoyancy tank base, and the diameter of this tank.

The ruler scale has been set to 30 meters

Orientation icon shows the ruler is in the 'upright' position.

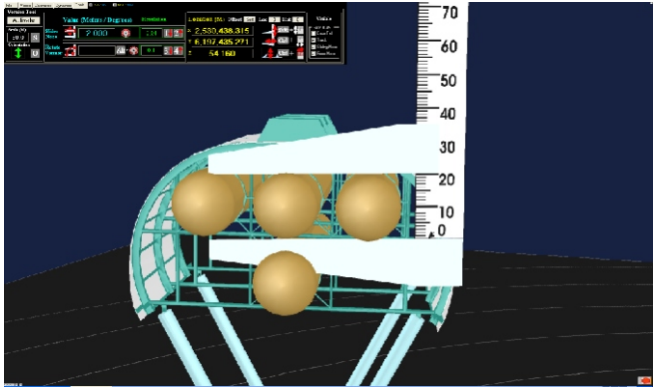
The caliber offset has been set to 2.000 meters.

No rotation data is displayed when the ruler is upright

An X and Y offset has been added, which is the turret center in WORLD Co-ordinates.

The 'Z' panel displays the height of the ruler base reference.

Vernier Tool		Value Meters / Degrees		Resolution		Location (M)		Offset		Loc		Rot		Visible	
Activate		Slider	2.000	0.01	1	2	X	2,530.438	315	Y	6,197.435	271	Z	54.160	Slide Rule
Scale (M)	30.0	S													Base Flat
Orientation															Track
															Sliding Nose
															Fixed Nose



## Center mooring line touchdown distance and angle, from the turret center

The ruler has been positioned in a flat orientation to measure the distance between the turret center and the center mooring line touchdown point. The measurement was facilitated by clicking the 'loc 0' button, which instantly snaps the ruler base to the turret center on the ground.

The ruler scale has been set to 300 meters

Orientation icon shows the ruler is in the flat position.

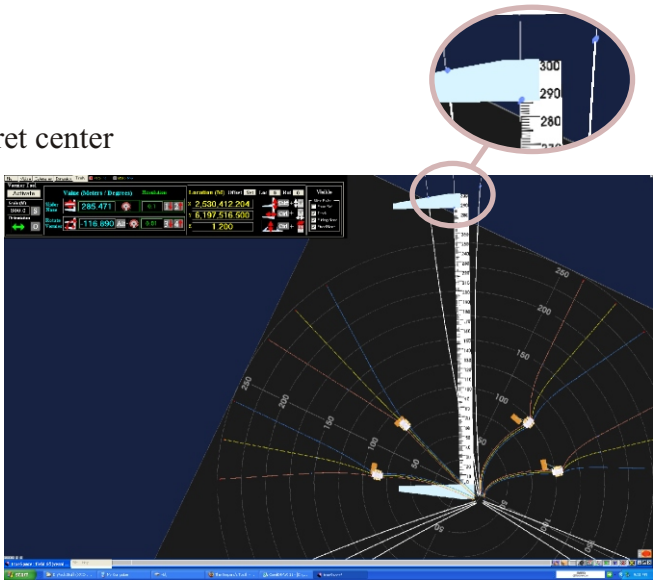
The caliber offset has been set to 285.471 meters.

The ruler has been rotated to an angle of 243.11 degrees.

The X and Y 'world' referenced co-ordinates display the turret center as the ruler base location.

The ruler height (Z), is raised slightly above the ground level, so the ruler can be seen above the map.

Vernier Tool		Value Meters / Degrees		Resolution		Location (M)		Offset		Loc		Rot		Visible	
Activate		Slider	285.471	0.1	1	2	X	2,530.412	204	Y	6,197.516	500	Z	1.200	Slide Rule
Scale (M)	300.0	S													Base Flat
Orientation															Track
															Sliding Nose
															Fixed Nose



## Height (ground referenced) of turret umbilical connector base

The ruler has been positioned in an upright orientation to measure the height of the turret umbilical connector base. The measurement was facilitated by clicking the 'loc 0' button, which instantly snaps the ruler base to the turret center on the ground. The ruler X and Y position, and slider nose offset, was then adjusted until the nose edge intersected with the target object.

The ruler scale has been set to 300 meters

Orientation icon shows the ruler is in the upright position.

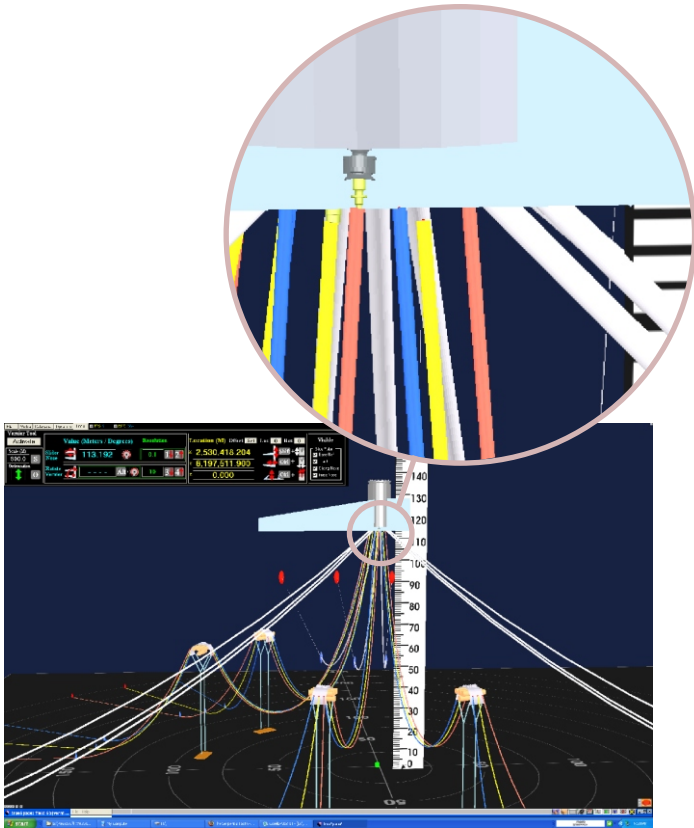
The caliber offset has been set to 113.19 meters.

No rotation data is displayed when the ruler is upright

The X and Y 'world' referenced co-ordinates display the turret center as the ruler base location.

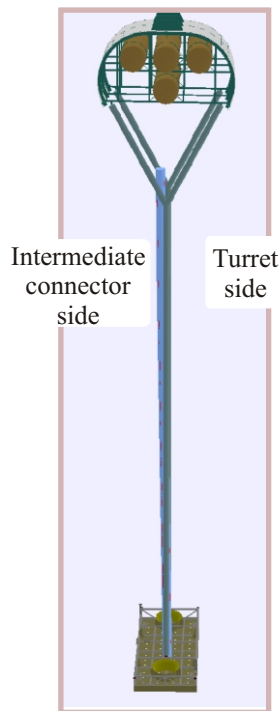
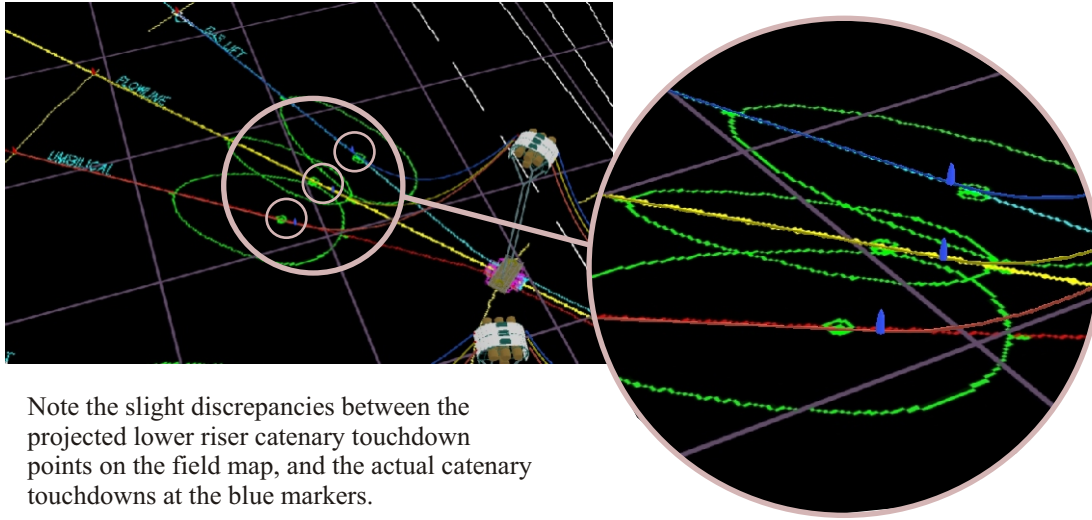
The ruler height (Z), is on the ground plane (0 height)

Vernier Tool		Value Meters / Degrees		Resolution		Location (M)		Offset		Loc		Rot		Visible	
Activate		Slider	113.192	0.1	1	2	X	2,530.418	204	Y	6,197.511	900	Z	0.000	Slide Rule
Scale (M)	300.0	S													Base Flat
Orientation															Track
															Sliding Nose
															Fixed Nose



# Conclusion

The field parameters that have been provided for this simulation have resulted in reasonably balanced MWA profiles. If the MWA heights, vessel offset, or catenary lengths had been different, the MWA would not have reflected such an 'upright' demeanor, as has been illustrated in this document. Whoever 'tuned' the field has done a good job. There are some minor discrepancies with the touchdown points of the lower risers. Refer to the image below for further analysis.



There is a slight lean in all the MWA's in towards the turret. This can be seen in the image on the left, when compared to the upright measurement marker. This indicates a slight imbalance in the catenary lengths.

The user of this software should keep in mind that this application has been developed primarily as a visualisation tool. There are many parameters that have not been provided and/or factored into the simulations that may account for the slight discrepancies outlined above.

We welcome and encourage any feedback about the package, so please keep the dialog open and provide us with all your thoughts and comments pertaining to the package and it's delivery.